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RESEARCH OF MOVING TARGET DECTION TECHNOLOGY IN INTELLIGENT VIDEO SURVEILLANCE SYSTEM

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ABSTRACT

Moving object detection is one of the most challenging tasks in intelligent video surveillance system. It aims to detect targets with a camera instead of human eyes and assist people to complete monitoring and control tasks. Moving target detection, classification, tracking, behavior understanding and description are included in intelligent video surveillance, but moving target detection is the key step. In this paper, according to the background is static or dynamic, the existing major moving target detection algorithms are divided into two categories. A detailed introduction is presented. Some methods such as frame subtraction, background subtraction and optical flow method are included in static background. Furthermore, other algorithms are also presented in dynamic scene, and finally the prospects of moving target detection are reviewed.

Keywords: *Moving Object Detection, Intelligent Video Surveillance, Static, Dynamic, Prospects*

1. INTRODUCTION

In recent years, with the increasingly demand for social security monitoring, monitoring technology has been developed to a new level. Video surveillance technology plays a major role in the field of security. The common video surveillance is used to set camera equipment for recording the scene at various monitoring points, transmitting the video information to the processing center and display through the transmission channel. Thus the monitoring personnel can monitor and analyze the scene directly. But this way has disadvantages which can not be ignored. Studies have shown that the attention of the monitoring personnel will be greatly reduced if they focus on the monitor screen for more than 20 minutes. So just rely on human eyes, a truly safe and reliable monitoring system can not be achieved. Obviously, the traditional video surveillance system based on the manual operation is unable to meet the requirements of the actual accuracy and security. The emergence of intelligent video surveillance technology just meets this demand. Intelligent video surveillance technology is based on the traditional video surveillance system, and the analytical ability to deal with the content of the scene is increased. To some extent, computer is used to assist people to complete monitoring tasks instead of people. Thus monitoring personnel will be able to free from a lot of useless information and just need to deal with information which is filtered by intelligent video analysis system. Intelligent video surveillance technology is a comprehensive science, image processing and analysis, pattern recognition, artificial intelligence are involved in. A typical workflow of intelligent video surveillance system is shown in Figure 1. The entire system mainly consists of four parts, target detection, target classification, target tracking and target behavior recognition. Target detection is the key step of the intelligent video surveillance, the results of this process is the basis of all the post-processing [1].

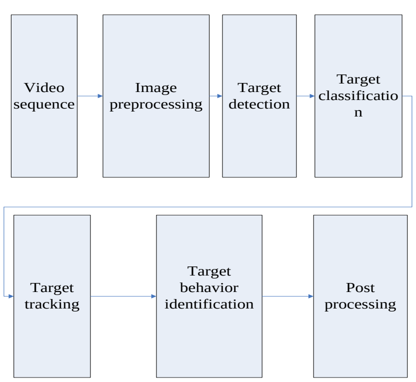

Figure1: A Typical Workflow Of Intelligent Video Surveillance System

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2. MOVING OBJECT DETECTION

There are two types of moving target detection, static background and dynamic background. For the static background, background subtraction, optical flow method and inter-frame difference are common used detection methods. For the dynamic background, global motion should be taken into account.

2.1 Static Background

2.1.1 Background subtraction

The background subtraction is a method to detect a motion area by using the difference of the current image and the background image.

(1) The establishment and update of the background model

For the static background of the video sequence, the background image is susceptible to the impact of the weather, light, shadow and other interference, so the background model needs to be updated. There are two methods to establish and update the background, parameter model [2, 3] and statistical estimation method [4, 5]. Gaussian distribution is used to establish the background model in parameter model and adjusts the parameters adaptively. Thus a new background image will be obtained. A series of images is used in statistical estimation method and the pixel gray is classified according to certain assumptions, and the appropriate pixels are chosen to form the background. In order to achieve more effective motion detection, Magee [2] not only built Gaussian mixture model for background, but also established more than one model of the target. For background modeling, Lin proposed a statistical method based on pixel gray [6]. Guo made use of the average values of multi-frame images [7]. Yang proposed a moving target detection method which combined Gaussian mixture model with spatial neighborhood pixels [8]. Yin improved the adaptive threshold algorithm, and the improved method has strong adaptability to the complex background environment [9]. Karmann[10] proposed adaptive background model based on Kalman filter. The method can adapt to changes in weather and light. The U.S. W4 monitoring system has been developed by the University of Maryland , which made use of the minimum, maximum intensity value and the maximum time differential value to build model for each pixel in the scene, and the model is updated periodically [11]. What's more, an efficient method is presented to deal with the existing problem through improvement on the background updating period using different learning rates for the estimated background and foreground pixels. The experiment result shows the method works better than the typical Gaussian mixture model [12]. A real-time system for object detection in outdoor environments using a graphics processing unit (GPU) is proposed. There are two algorithms on a GPU: adaptive background model, and margined sign correlation. These algorithms can detect moving objects and remove shadow regions robustly. Experimental results demonstrate the real-time performance of the proposed system [13].

(2) Shadow detection and removal

Due to the influence of light, the shadow of the moving target is often detected as moving target, leading to the misjudgment of the tracking system, so the shadow should be removed. There are two kinds of shadow detection and removal methods, one is based on shadow feature, and the other one is based on the geometric model. The main features of the shadow are texture, color, and geometry characteristics. The characteristics of the shadow are used to detect a motion region, and further separate the object from the shadow. HSV color space is used [14], the phenomenon of the luminance values in the shaded region is reduced but the changes of hue and saturation is still within a certain range is used to identify shadows. The method is used widely. Geometric characteristics of the camera positions and scene surface are used to detect shadows in geometric model. This method requires a lot of assumptions and prior knowledge. For example, target needs to be perpendicular to the ground, and the clear camera and light source position are also required. Koller[15] made use of three-dimensional vehicles to match the geometric model vehicles and made use of transcendental illumination model, and then the projection of the vehicle in the road will be obtained. This method is based on the priori knowledge, only applied to a particular scene. Due to the computational complexity, it is not suitable for real-time applications. Kang[16] presented a new method of detecting highway vehicles for active safety vehicle system, combined a projective invariant technique with motion information to detect overtaking road vehicles. The vehicles are assumed into a set of planes and the invariant technique extracts the plane from the theory that a geometric invariant value defined by five points on a plane is preserved under a projective transform. Harris corners as a salient image point are used to give motion information with the normalized cross correlation centered at these points. The method is very fast, real-time processing is possible for vehicle detection. What's more, Sebastian [17] presented a powerful framework for detections of moving

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objects in real-time video processing applications under various lighting changes. The novel approach is based on a combination of edge detection and recursive smoothing techniques. Edge dependencies are used as statistical features of foreground and background regions and the foreground is defined as regions containing moving edges. The background is described by short- and long-term estimates. Experiments prove the robustness of our method in the presence of lighting changes in sequences compared to other widely used background subtraction techniques.

2.1.2 Optical flow method

The moving target is detected through the study of optical flow field of the image sequence in optical flow method. Optical flow field contains important information of the moving target. Optical flow is motion vector of the pixel in the image grayscale mode. The key step of the optical flow method is to obtain the optical flow information of the moving target. In the calculation of the optical flow field, the movement of the object is typically continuous in space should be taken into account. Therefore, the change of the image is continuous, so it can be assumed that the gray value of the image is not change, optical flow equation can be obtained as follows.

$$\frac{\partial E}{\partial X}+\frac{\partial E}{\partial Y}+\frac{\partial E}{\partial T}=0 \quad (1)$$

However, only this one equation, two mutually independent velocity components *u* and *v* can not be solved out. Therefore, the new constraints should be added. For example, Gradient-based method, energy-based approach, area-based matching method, phase-based approaches are proposed. As can be seen from the above analysis, the moving target can be detected in the case of unknown scene information by optical flow method, and higher detection accuracy can be achieved than the background subtraction and frame difference method. What's more, target occlusion problem can be solved. However, due to the computational complexity and huge amount of computation, unless there is a special hardware support or optical flow method is difficult to meet real-time requirements. Optical flow method is particularly sensitive to noise and easy to produce incorrect results. There is still a lot of distance between the optical flow method and the actual use because of these shortcomings. Deng [18] made use of the inter-frame difference method to obtain a moving target area firstly and then made use of optical flow method to obtain accurate target detection of these areas. The low accuracy of the inter-frame difference method and the disadvantages of optical flow method can be avoided by this approach. Andreas [19] presented an approach for identifying and segmenting moving objects from dense scene flow information independently, using a moving stereo camera system. The disparity, change in disparity, and the optical flow are estimated in the image domain and the three-dimensional motion is inferred from the binocular triangulation of the translation vector. Using error propagation and scene flow reliability measures, dense motion likelihoods to every pixel of a reference frame is assigned. These likelihoods are then used for the segmentation of independently moving objects in the reference image. The improvement can be demonstrated systematically using reliability measures for the scene flow variables. Furthermore, the binocular segmentation of independently moving objects is compared with a monocular version, using solely the optical flow component of the scene flow.

2.1.3 Frame difference method

Inter-frame difference method is calculated by the difference between consecutive two or three images, and then the information of moving object can be obtained, such as the location and shape of the moving target. The inter-frame difference method is simple and with strong self-adaptability to the dynamic environment. But there are some limitations. Firstly, it can not detect the complete target, and easy to produce small holes. Secondly, it is not sensitive to the slow movement of objects and the detected object is often larger than real object. In order to improve the performance of the inter-frame difference method, He [20] proposed fast symmetric difference method, and it can be used to detect the shape of the moving object accurately. Zhao [21] proposed a method which worked mainly by using gradient information, three-frame-differencing and connectivity-testing-based noise reduction. The results of theoretical analyses and computer simulation showed that the method has some advantages over its competitors, a wider application range, a less computation complexity and a faster processing speed. Thus, this method can be worked in a noisy environment with robustness.

2.2 Dynamic Background

In dynamic background, the region which contains global motion is defined as background and the region which contains local motion is defined as foreground. The global motion is the overall movement of all of the pixels in the sequence of images, which is caused by the movements of the camera. There are three kinds of methods to detect moving object in dynamic

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background: motion compensation method, motion segmentation method, regional integration method [22].

2.2.1 Motion compensation method

The motion compensation is a method which can describe the difference among adjacent frames. Firstly its own movement is calculated and the movement of the camera is compensated. Secondly the static background detection algorithm is used to detect the moving object. The motion compensation method is divided into two major categories. The first method is block motion compensation [23], each frame of the video sequence is divided into a number of pixel blocks, and the current block is predicted and also to be compensated according to the reference block. The other method is global motion compensation [24], the motion model is used to estimate the law of motion of the background area which is caused by the motion of camera.

2.2.2 Motion segmentation method

This method is used to complete the moving target segmentation by calculating the motion vector of the pixels in the horizontal direction. The segmentation based on the optical flow method, the segmentation based on change detection, parameterization method and the Bayesian segmentation method are included.

2.2.3 Regional integration method

The moving target is segmented which makes use of the visual characteristics, and then the motion parameters are calculated. LI [25] proposed the image segmentation methods based on wavelet transformation and feature weight, which can segment random texture image.

3 CONCLUSIONS

Intelligent video surveillance technology is a challenging study which has important theoretical significance and practical value. Moving target detection is the key step of intelligent video surveillance. The common used methods of moving target detection are reviewed in this paper. Most of the existing target detection methods are only based on engineering perspective. There are still some difficulties to be solved, such as the change of environment and lighting conditions, noise, shadows, and occlusion. From the analysis of the human visual process, bionics research will be a new way of moving target detection.

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